MANUAL DE INSTALACIÓN “MONITOR PERMANENTE DE TEMPERATURA(MPT)”

DISI-TEAM

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Capítulo 1

INTRODUCCIÓN

La asignatura “Fundamentos de Electricidad y Magnetismo” dirigida por el profesor Jaime Villalobos Velasco, brinda a los estudiantes de la Universidad Nacional de Colombia la oportunidad de interactuar con proyectos de investigación desde el inicio de su carrera y la posibilidad de trabajar en grupo con estudiantes de otras carreras. En este caso se busca implementar un proyecto piloto de redes de monitoreo en diferentes puntos cardinales de la ciudad de Bogotá. Para esto se requiere principalmente: Placa “Arduino Uno”, sensor de temperatura LM35, computador con conexión de internet constante.

El presente manual brinda una guia sobre la implementación de la estación de monitoreo. Inicialmente se encuentran los materiales usados, enseguida los procedimientos que se requieren(Instalación Placa - Sensor, Comunicación Placa - PC,Interfaz “Arduino”,Envio Datos - Servidor) , finalmente los anexos que el estudiante necesita para guia en el montaje. Se debe tener en cuenta que cada grupo esta en la autonomía de presentar sus informes y en ningún momento se esta obligando a los integrantes de la materia.

Capítulo 2

MATERIALES

2.1. Placa Arduino Uno

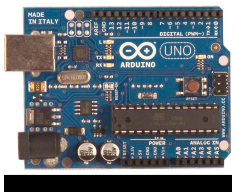


Figura 2.1.1: Placa Arduino UNO.

2.2. Sensor de Temperatura LM35

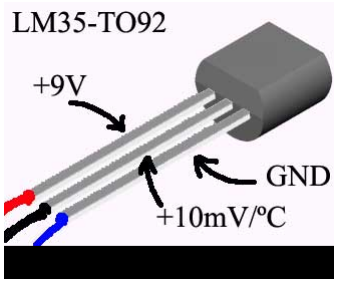


Figura 2.2.1: Sensor de Temperatura LM35.

2.3. Resistencia 220 Ω

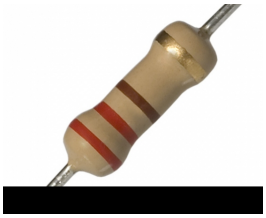


Figura 2.3.1: Resistencia 220 Ω.

2.4. Protoboard

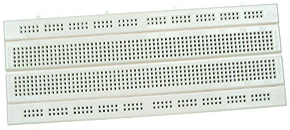


Figura 2.4.1: Protoboard usada para realizar el montaje.

2.5. Cable USB Tipo AB

Figura 2.5.1: Cable USB Tipo AB.

2.6. Computador

Figura 2.6.1: Computador de Escritorio.

Figura 2.6.2: Computador Portátil.

Capítulo 3

PROCEDIMIENTO

3.1. Instalación Placa - Sensor

a) Planear el sitio donde se va a ubicar la estación de trabajo. Teniendo en cuenta los siguientes aspectos:

-El monitor deberá estar ubicado cerca a una ventana para dejar el sensor en la parte exterior de la habitación donde se sitúe.

-El computador que capture los datos tendrá acceso a internet todo el tiempo.

b) Revisar el estado de la placa. El sello de garantía debe estar en el respectivo empaque, en caso de encontrarse alguna anomalía informar directamente al distrbuidor del mismo.

Figura 3.1.1: Empaque placa “Arduino Uno”.

c) Revisar el estado del sensor de temperatura “LM35”, en caso de encontrarse alguna anomalia informar directamente al distribuidor del mismo.

d) Consultar el manual del sensor en la sección “Anexos”, identificar las patas (Vs, GND, Vout).

e) Soldar un cable a cada extremo de las patas del sensor, se recomienda dejar cada cable con una longitud entre 1 y 2 metros para que se conecte a la protoboard.

f) Consultar el manual de uso de la protoboard en la sección “Anexos”, para realizar el montaje propuesto en el paso siguiente.

g) Realizar el montaje de la figura 3.1.2, cada equipo de trabajo esta en la autonomía de realizar el montaje según su caso particular, se debe tener en cuenta que la placa no debe estar conectada.

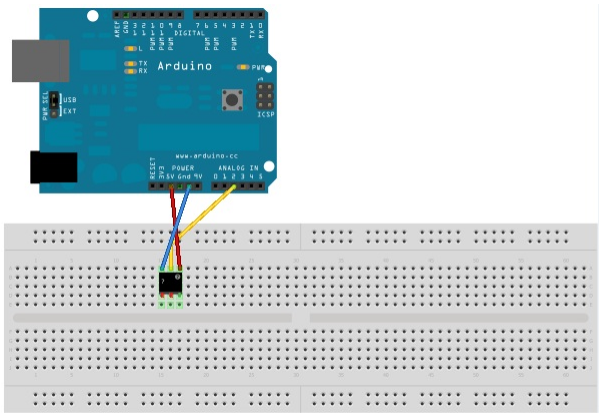


Figura 3.1.2: Montaje Placa-Sensor.

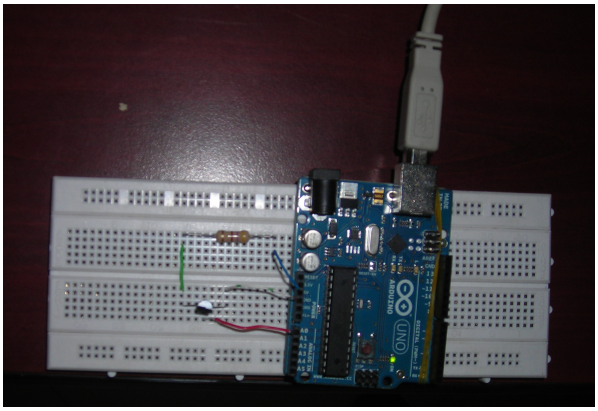


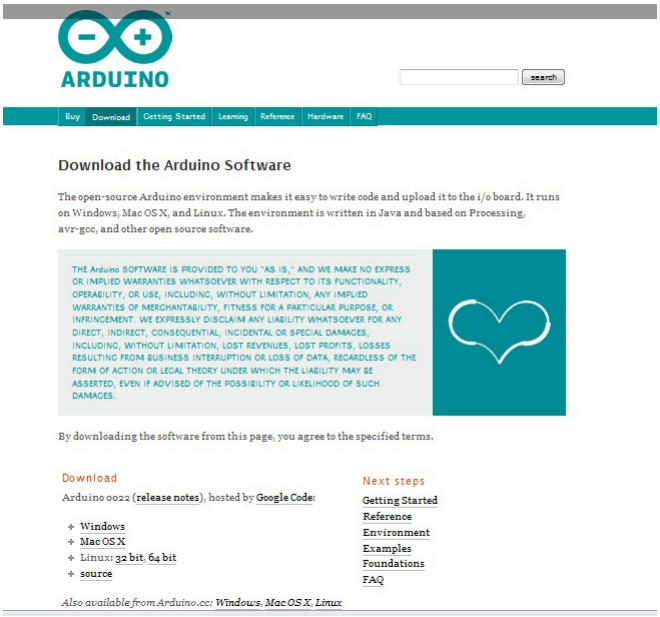
Figura 3.1.3: Estación Equipo de Trabajo.

3.2. Comunicación Placa - PC

a) Identificar el sistema operativo del computador usado para la recepción de la información.(Windows, Linux, Mac)

Figura 3.2.1: Sistemas Operativos Soporte Placa Arduino.

b) Para este manual de instalación, el sistema operativo usado es Windows. Nos dirigimos al sitio web Arduino-Software.


ARDUINO
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Buy
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Getting Started
Learning
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Hardware
FAQ
Download the Arduino Software
The open-source Arduino environment makes it easy to write code and upload it to the i/o board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing, avr-gcc, and other open source software.
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Also available from Arduino.cc: Windows, Mac OS X, Linux
Next steps
Getting Started
Reference
Environment
Examples
Foundations
FAQ

Figura 3.2.2: Sitio Web Arduino.

c) Descargamos el paquete “arduino-022.zip” con un peso aproximado de 85 Mb.

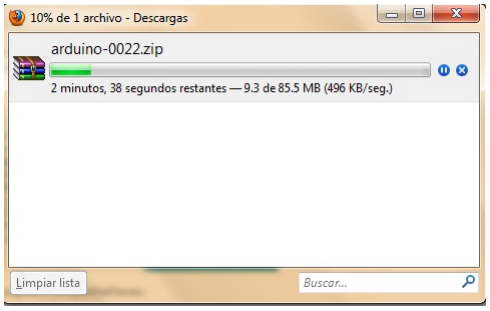


Figura 3.2.3: Descarga de paquete “arduino-022.zip”.

d) Se extrae el paquete “arduino-022.zip” en una ubicación que sea de fácil recordación para el equipo de trabajo.

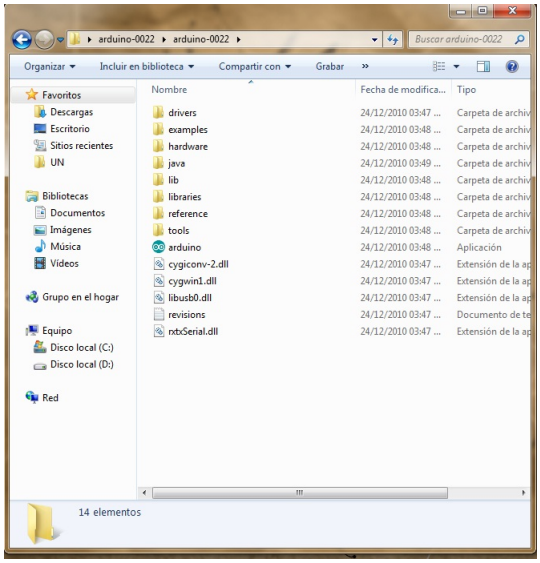


Figura 3.2.4: Extracción paquete “arduino-022.zip”.

e) Realizar la conexión entre el computador y la placa por medio del cable USB. Como es un dispositivo desconocido se requiere el proceso de instalación.

f) Seleccionar la segunda opción del asistente de “Hardware Encontrado” como se muestra en la figura 3.2.5.

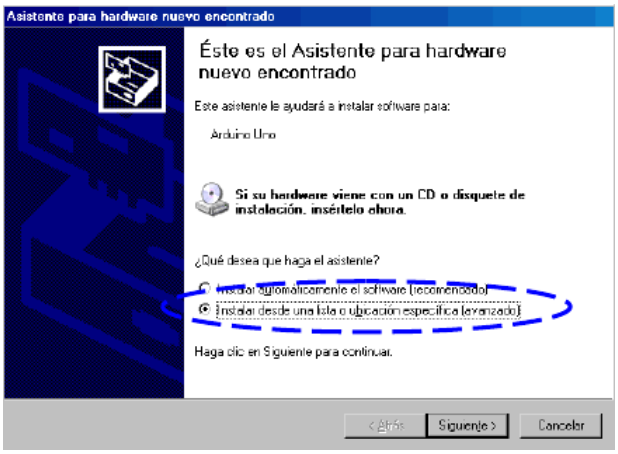

Asistente para hardware nuevo encontrado
Éste es el Asistente para hardware nuevo encontrado
Este asistente le ayudará a instalar software para:
Arduino Uno
Si su hardware viene con un CD o disquete de instalación, insértelo ahora.
¿Qué desea que haga el asistente?
Instalar automáticamente el software (recomendado)
Instalar desde una lista o ubicación específica (avanzado)
Haga clic en Siguiente para continuar.
< Atrás
Siguiente >
Cancelar

Figura 3.2.5: Pantallazo I (Proceso de Instalación).

g) Escoger la primera opción del asistente de “Hardware Encontrado”, luego ubicar la carpeta “Drivers” que se encuentra en el paquete del paso “d”, como se muestra en la figura 3.2.6.

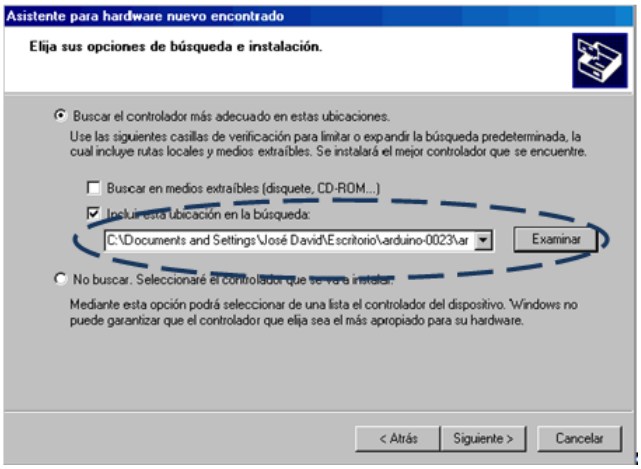

Asistente para hardware nuevo encontrado
Elija sus opciones de búsqueda e instalación.
Buscar el controlador más adecuado en estas ubicaciones.
Use las siguientes casillas de verificación para limitar o expandir la búsqueda predeterminada, la cual incluye rutas locales y medios extraíbles. Se instalará el mejor controlador que se encuentre.
Buscar en medios extraíbles (disquete, CD-ROM...)
Incluir esta ubicación en la búsqueda:
C:\Documents and Settings\José David\Escritorio\arduino-0023\dr
Examinar
No buscar. Seleccionaré el controlador que se va a instalar
Mediante esta opción podrá seleccionar de una lista el controlador del dispositivo. Windows no puede garantizar que el controlador que elija sea el más apropiado para su hardware.
< Atrás
Siguiente >
Cancelar

Figura 3.2.6: Pantallazo II (Proceso de Instalación).

h) A continuación se realiza el proceso de instalación en la máquina, en el caso de Windows Xp se elige la opción “Continuar”, como se muestra en la figura 3.2.7.

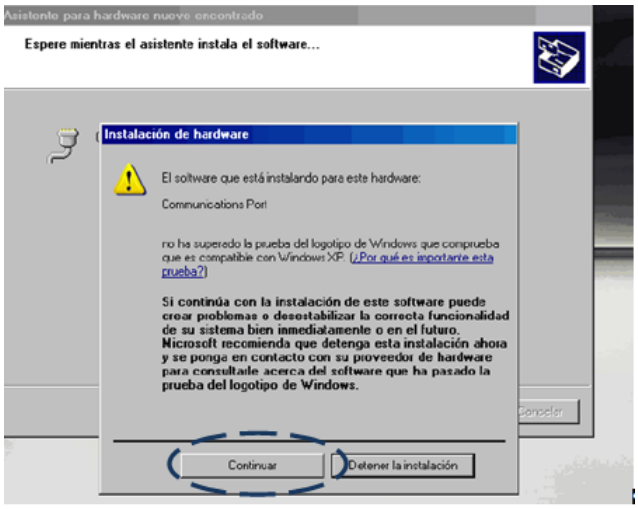

Asistente para hardware nuevo encontrado
Espere mientras el asistente instala el software...
Instalación de hardware
El software que está instalando para este hardware:
Communications Port
no ha superado la prueba del logotipo de Windows que comprueba que es compatible con Windows XP. (¿Por qué es importante esta prueba?)
Si continúa con la instalación de este software puede crear problemas o desestabilizar la correcta funcionalidad de su sistema bien inmediatamente o en el futuro. Microsoft recomienda que detenga esta instalación ahora y se ponga en contacto con su proveedor de hardware para consultarle acerca del software que ha pasado la prueba del logotipo de Windows.
Continuar
Detener la instalación

Figura 3.2.7: Pantallazo III (Proceso de Instalación).

i) El proceso de instalación del periférico ha finalizado de forma exitosa. En seguida se comprueba en “Administrador de Dispositivos” (Método Abreviado=Tecla Windows+Pausa) que no se presenten conflictos e identificar la ubicación del puerto.

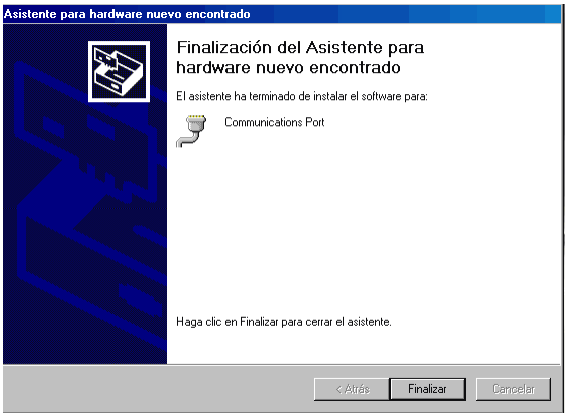

Asistente para hardware nuevo encontrado
Finalización del Asistente para hardware nuevo encontrado
El asistente ha terminado de instalar el software para:
Communications Port
Haga clic en Finalizar para cerrar el asistente.
< Atrás
Finalizar
Cancelar

Figura 3.2.8: Pantallazo IV (Proceso de Instalación).

En este caso la placa esta ubicada en el puerto “Com 3“.

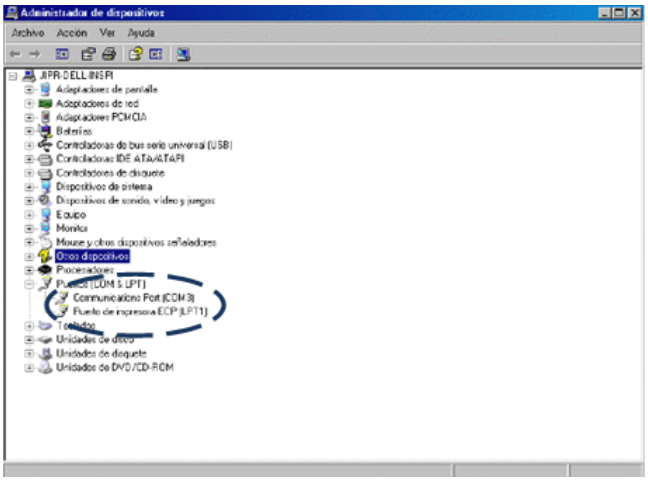


Figura 3.2.9: Pantallazo “Administrador de Dispositivos”

3.3. Interfaz “Arduino”

Teniendo en cuenta que la aplicación esta desarrollada en lenguaje “Java”, se debe bajar el complemento en la siguiente página.Complemento Java.

Java
Buscar
Java en acción
Descargas
Centro de ayuda
Todos los archivos de descarga de Java
Si desea descargar Java en otro equipo o sistema operativo, haga clic en el siguiente vínculo.
Todos los archivos de descarga de Java
Descarga gratuita de Java
Descargue ya Java en su equipo.
Version 6 Update 29
Descarga gratuita de Java
» ¿Qué es Java? » ¿Tengo Java? » ¿Necesita ayuda?
¿Qué es Java?
Java le permite jugar en línea, participar en sesiones de chat con internautas de todo el mundo, calcular los intereses de una hipoteca y ver imágenes en tres dimensiones, entre otras muchas aplicaciones. Es también esencial para las aplicaciones de intranet y otras soluciones de comercio electrónico que constituyen la base informática de las empresas.
> Obtenga más información sobre Java
Después de descargar Java, visite java.com para conocer Java en acción (sitio en inglés) en su vida diaria.

Figura 3.3.1: Complemento “Java”.

a) En el paquete que se obtuvo, se ejecuta el archivo “Arduino”, como se muestra en la figura 3.3.2.

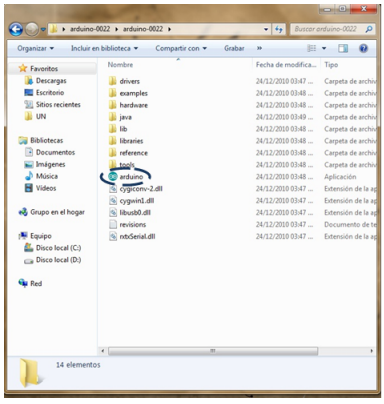


Figura 3.3.2: Aplicación Arduino (Ejecutable).

b) La interfaz de la aplicación presenta: Área de código, barra de herramientas y barra de menús.

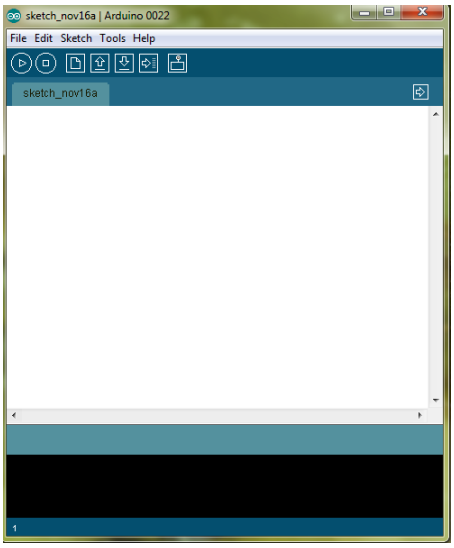


Figura 3.3.3: Interfaz “Arduino”.

c) Antes de realizar alguna tarea, se debe configurar el puerto. Nos ubicamos en la parte superior en “Tools”, luego “Serial Port”, finalmente se selecciona el puerto. No olvidar la asignación de la placa en la lista de dispositivos del computador.

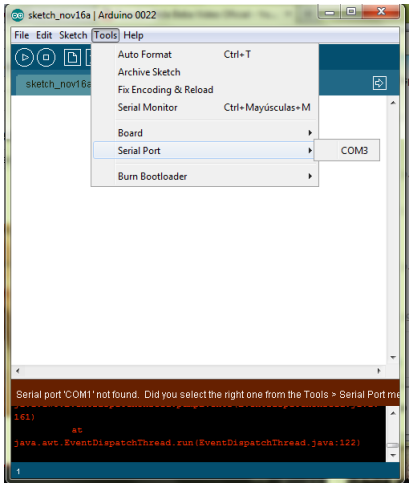


Figura 3.3.4: Configuración Puerto.

d) Ubicar en el área de trabajo el siguiente código, éste permite visualizar la captura de la temperatura en el intervalo de tiempo que el grupo de trabajo desee.Tener en cuenta que la variable inicial “int tempPin = 0” concuerde con la conexión hecha anteriormente.

Algorithm 3.1 Código de visualización de Datos “Placa”.

```
1  //declare variables
2  float tempC;
3  int tempPin = 0;
4
5  void setup()
6  {
7  Serial.begin(9600); //opens serial port, sets data rate to 9600 bps
8  }
9
10 void loop()
11 {
12 tempC = analogRead(tempPin); //read the value from the sensor
13 tempC = (500 * tempC)/1024.0; //convert the analog data to temperature
14 Serial.println(tempC);
15 delay(500); //wait one second before sending new data
16 }
```

e) Ejecutar el icono “Verify”, esperar que en la parte inferior aparezca el mensaje “Done Compiling”.

sketch_nov16a | Arduino 0022
File Edit Sketch Tools Help
sketch_nov16a §
//declare variables
float tempC;
int tempPin = 0;
void setup()
{
Serial.begin(9600); //opens serial port, sets data rate to 9600 bp
}
void loop()
{
tempC = analogRead(tempPin); //read the value from the sensor
tempC = (500 * tempC)/1024.0; //convert the analog data to tempera
Serial.println(tempC);
delay(500); //wait one second before sending new data
}
Done compiling.
Binary sketch size: 3602 bytes (of a 32256 byte maximum)
16

Figura 3.3.5: Tarea de verificación de código.

f) Activar el icono “Upload”, esperar que en la parte inferior aparezca el mensaje “Done Upload(Confirmar)”.

Figura 3.3.6: Tarea de Actualizar Placa - PC.

g) Visualizar la temperatura por medio de “Serial Monitor”.

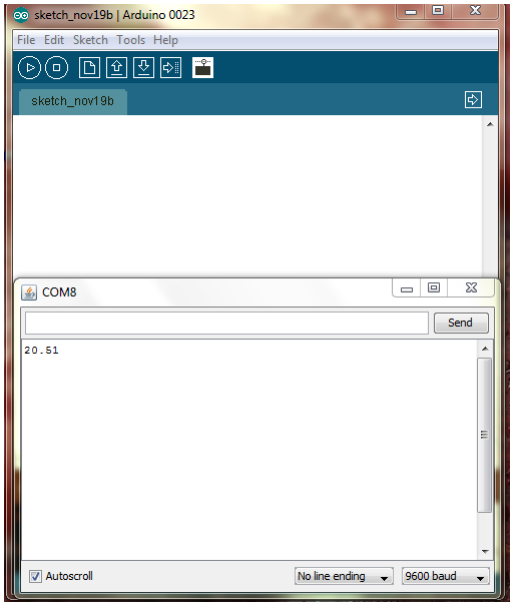


Figura 3.3.7: Serial Monitor.

3.4. Envio Datos - Servidor

a) Instalar la aplicación “Instalador”, se encuentra publicada en el sitio web del curso.Aplicación Ïnstalador".

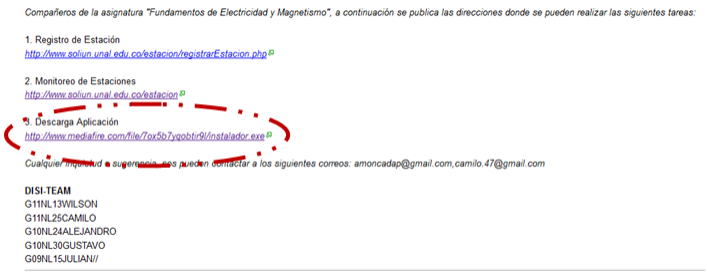


Figura 3.4.1: Aplicación MPT.

b) La aplicación “Estación de Monitoreo” queda instalada por defecto en el directorio(C:\estacionDeMonitoreo).

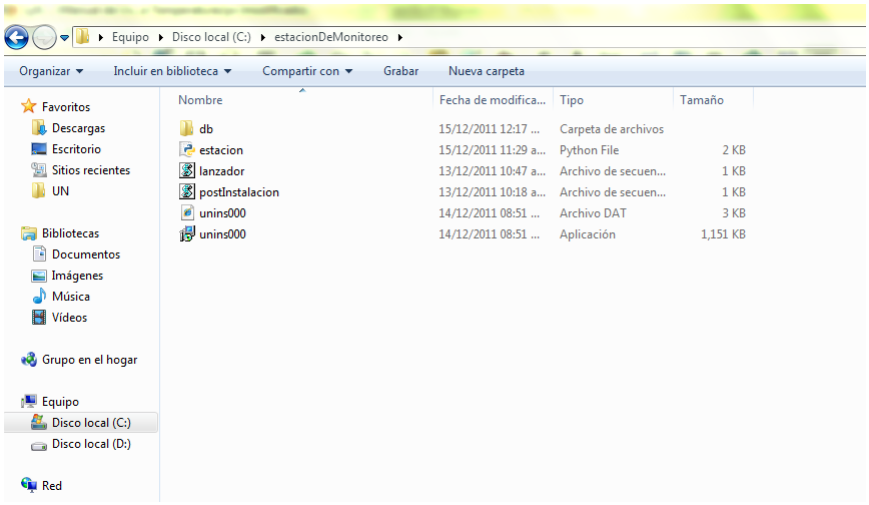


Figura 3.4.2: Directorio de Aplicación.

c) Ahora se debe registrar la estación de monitoreo, para esto nos dirigimos al sitio web que se encuentra publicado en la página del curso.Registro de Estación En esta parte se debe ubicar el punto en la ciudad de Bogotá, enseguida seleccionar el puerto serial que fue asignado por el computador y finalmente se registra un usuario por grupo de trabajo con el correo institucional.

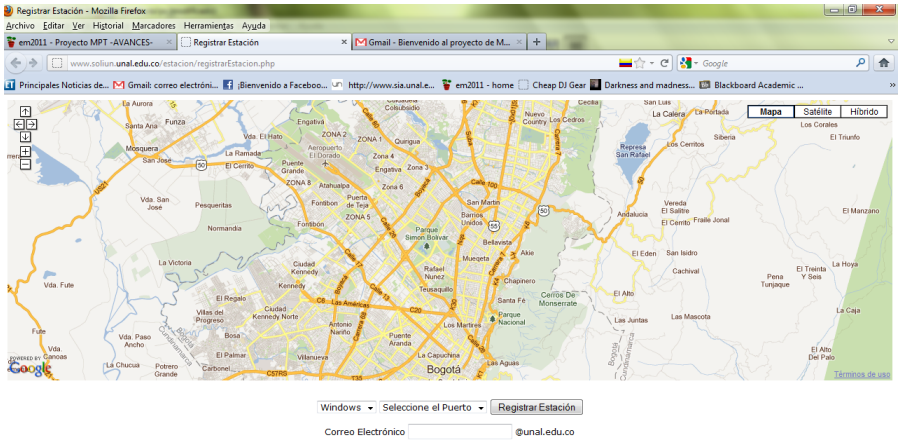


Figura 3.4.3: Registro de Estación.

d) Revisar el correo registrado en el enunciado anterior, a continuación se valida la estación. Además de esto se debe copiar el archivo “conf.ini “ en el directorio donde se instalo la aplicación.

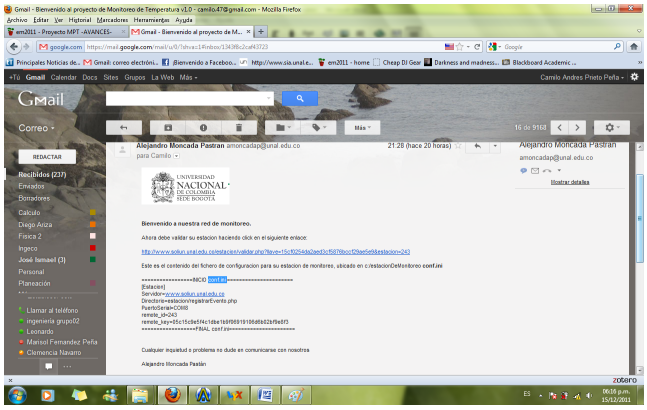


Figura 3.4.4: Correo enviado por DISI-Team.

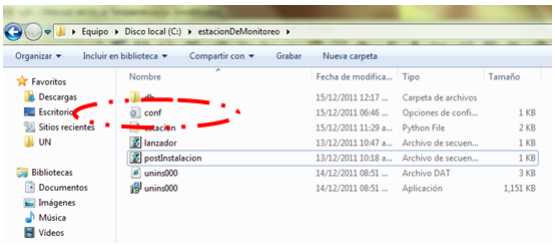


Figura 3.4.5: Archivo “conf.ini” en directorio.

e) Dirigirse al monitoreo de estaciones Monitoreo de Estaciones para confirmar que el proceso se ha culminado.

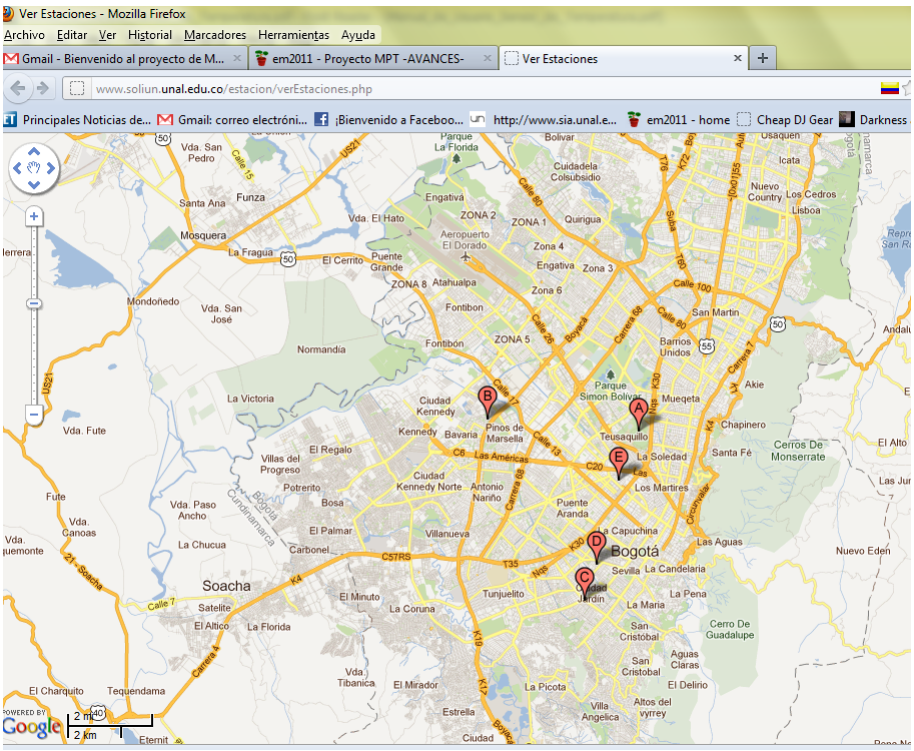


Figura 3.4.6: Monitoreo de Estaciones - Bogotá D.C

f) Cualquier inquietud o sugerencia sobre el funcionamiento de la aplicación, favor escribir a los siguientes correos: camilo.47@gmail.com, amoncadap@gmail.com.

Capítulo 4

Anexos

4.1. Documento Oficial Sensor LM35

National Semiconductor

November 2000

LM35
Precision Centigrade Temperature Sensors

General Description

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±¼°C typical
- Low impedance output, 0.1 Ω for 1 mA load

Typical Applications

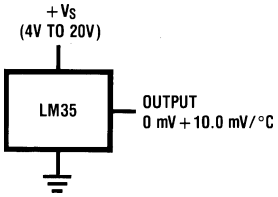
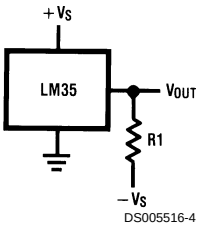


FIGURE 1. Basic Centigrade Temperature Sensor (+2°C to +150°C)



Choose $R_1 = -V_S/50\ \mu A$

V_{OUT} = +1,500 mV at +150°C
= +250 mV at +25°C
= −550 mV at −55°C

FIGURE 2. Full-Range Centigrade Temperature Sensor

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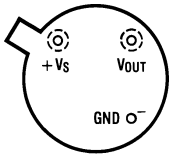
Connection Diagrams

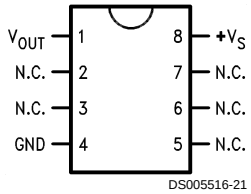
TO-46
Metal Can Package*



*Case is connected to negative pin (GND)

Order Number LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

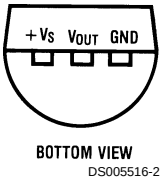
SO-8
Small Outline Molded Package



N.C. = No Connection

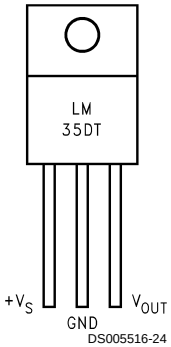
Top View
Order Number LM35DM
See NS Package Number M08A

TO-92
Plastic Package



Order Number LM35CZ, LM35CAZ or LM35DZ
See NS Package Number Z03A

TO-220
Plastic Package*



*Tab is connected to the negative pin (GND).
Note: The LM35DT pinout is different than the discontinued LM35DP.

Order Number LM35DT
See NS Package Number TA03F

Absolute Maximum Ratings (Note 10)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage	+35V to −0.2V
Output Voltage	+6V to −1.0V
Output Current	10 mA
Storage Temp.;	
TO-46 Package,	−60˚C to +180˚C
TO-92 Package,	−60˚C to +150˚C
SO-8 Package,	−65˚C to +150˚C
TO-220 Package,	−65˚C to +150˚C
Lead Temp.:	
TO-46 Package, (Soldering, 10 seconds)	300˚C
TO-92 and TO-220 Package, (Soldering, 10 seconds)	260˚C
SO Package (Note 12)	
Vapor Phase (60 seconds)	215˚C
Infrared (15 seconds)	220˚C
ESD Susceptibility (Note 11)	2500V
Specified Operating Temperature Range: T_{MIN} to T_{MAX} (Note 2)	
LM35, LM35A	−55˚C to +150˚C
LM35C, LM35CA	−40˚C to +110˚C
LM35D	0˚C to +100˚C

Electrical Characteristics

(Notes 1, 6)

Parameter	Conditions	LM35A			LM35CA			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy	T_A=+25˚C	±0.2	±0.5		±0.2	±0.5		˚C
(Note 7)	T_A=−10˚C	±0.3			±0.3		±1.0	˚C
	T_A=T_{MAX}	±0.4	±1.0		±0.4	±1.0		˚C
	T_A=T_{MIN}	±0.4	±1.0		±0.4		±1.5	˚C
Nonlinearity (Note 8)	T_{MIN}≤T_A≤T_{MAX}	**±0.18**		**±0.35**	**±0.15**		**±0.3**	˚C
Sensor Gain (Average Slope)	T_{MIN}≤T_A≤T_{MAX}	**+10.0**	**+9.9, +10.1**		**+10.0**		**+9.9, +10.1**	mV/˚C
Load Regulation (Note 3) 0≤I_L≤1 mA	T_A=+25˚C	±0.4	±1.0		±0.4	±1.0		mV/mA
	T_{MIN}≤T_A≤T_{MAX}	**±0.5**		**±3.0**	**±0.5**		**±3.0**	mV/mA
Line Regulation (Note 3)	T_A=+25˚C	±0.01	±0.05		±0.01	±0.05		mV/V
	4V≤V_S≤30V	**±0.02**		**±0.1**	**±0.02**		**±0.1**	mV/V
Quiescent Current (Note 9)	V_S=+5V, +25˚C	56	67		56	67		µA
	V_S=+5V	**105**		**131**	**91**		**114**	µA
	V_S=+30V, +25˚C	56.2	68		56.2	68		µA
	V_S=+30V	**105.5**		**133**	**91.5**		**116**	µA
Change of Quiescent Current (Note 3)	4V≤V_S≤30V, +25˚C	0.2	1.0		0.2	1.0		µA
	4V≤V_S≤30V	**0.5**		**2.0**	**0.5**		**2.0**	µA
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.5**	**+0.39**		**+0.5**	µA/˚C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L=0	+1.5		+2.0	+1.5		+2.0	˚C
Long Term Stability	T_J=T_{MAX}, for 1000 hours	±0.08			±0.08			˚C

Electrical Characteristics

(Notes 1, 6)

Parameter	Conditions	LM35			LM35C, LM35D			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy,	T_A=+25˚C	±0.4	±1.0		±0.4	±1.0		˚C
LM35, LM35C	T_A=−10˚C	±0.5			±0.5		±1.5	˚C
(Note 7)	T_A=T_{MAX}	±0.8	±1.5		±0.8		±1.5	˚C
	T_A=T_{MIN}	±0.8		±1.5	±0.8		±2.0	˚C
Accuracy, LM35D	T_A=+25˚C				±0.6	±1.5		˚C
(Note 7)	T_A=T_{MAX}				±0.9		±2.0	˚C
	T_A=T_{MIN}				±0.9		±2.0	˚C
Nonlinearity	T_{MIN}≤T_A≤T_{MAX}	**±0.3**		**±0.5**	**±0.2**		**±0.5**	˚C
(Note 8)								
Sensor Gain	T_{MIN}≤T_A≤T_{MAX}	**+10.0**	**+9.8, +10.2**		**+10.0**		**+9.8, +10.2**	mV/˚C
(Average Slope)								
Load Regulation	T_A=+25˚C	±0.4	±2.0		±0.4	±2.0		mV/mA
(Note 3) 0≤I_L≤1 mA	T_{MIN}≤T_A≤T_{MAX}	**±0.5**		**±5.0**	**±0.5**		**±5.0**	mV/mA
Line Regulation	T_A=+25˚C	±0.01	±0.1		±0.01	±0.1		mV/V
(Note 3)	4V≤V_S≤30V	**±0.02**		**±0.2**	**±0.02**		**±0.2**	mV/V
Quiescent Current	V_S=+5V, +25˚C	56	80		56	80		µA
(Note 9)	V_S=+5V	**105**		**158**	**91**		**138**	µA
	V_S=+30V, +25˚C	56.2	82		56.2	82		µA
	V_S=+30V	**105.5**		**161**	**91.5**		**141**	µA
Change of	4V≤V_S≤30V, +25˚C	0.2	2.0		0.2	2.0		µA
Quiescent Current	4V≤V_S≤30V	**0.5**		**3.0**	**0.5**		**3.0**	µA
(Note 3)								
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.7**	**+0.39**		**+0.7**	µA/˚C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L=0	+1.5		+2.0	+1.5		+2.0	˚C
Long Term Stability	T_J=T_{MAX}, for 1000 hours	±0.08			±0.08			˚C

Note 1: Unless otherwise noted, these specifications apply: −55˚C≤T_J≤+150˚C for the LM35 and LM35A; −40˚C≤T_J≤+110˚C for the LM35C and LM35CA; and 0˚C≤T_J≤+100˚C for the LM35D. V_S=+5Vdc and I_{LOAD}=50 µA, in the circuit of *Figure 2*. These specifications also apply from +2˚C to T_{MAX} in the circuit of *Figure 1*. Specifications in **boldface** apply over the full rated temperature range.

Note 2: Thermal resistance of the TO-46 package is 400˚C/W, junction to ambient, and 24˚C/W junction to case. Thermal resistance of the TO-92 package is 180˚C/W junction to ambient. Thermal resistance of the small outline molded package is 220˚C/W junction to ambient. Thermal resistance of the TO-220 package is 90˚C/W junction to ambient. For additional thermal resistance information see table in the Applications section.

Note 3: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

Note 4: Tested Limits are guaranteed and 100% tested in production.

Note 5: Design Limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

Note 6: Specifications in **boldface** apply over the full rated temperature range.

Note 7: Accuracy is defined as the error between the output voltage and 10mv/˚C times the device's case temperature, at specified conditions of voltage, current, and temperature (expressed in ˚C).

Note 8: Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

Note 9: Quiescent current is defined in the circuit of *Figure 1*.

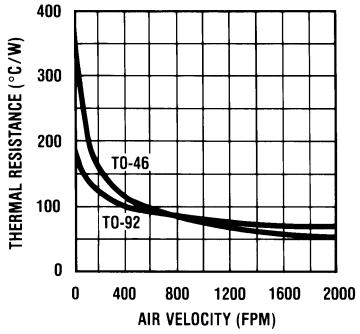
Note 10: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions. See Note 1.

Note 11: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

Note 12: See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" or the section titled "Surface Mount" found in a current National Semiconductor Linear Data Book for other methods of soldering surface mount devices.

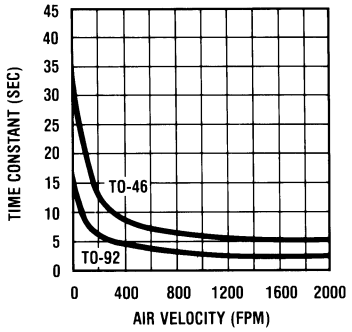
Typical Performance Characteristics

Thermal Resistance Junction to Air



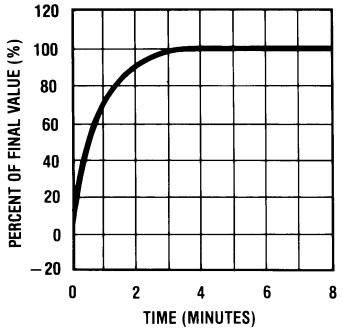
DS005516-25

Thermal Time Constant



DS005516-26

Thermal Response in Still Air



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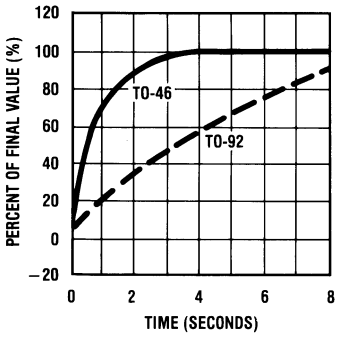
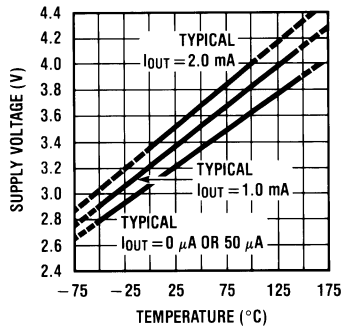
Thermal Response in Stirred Oil Bath



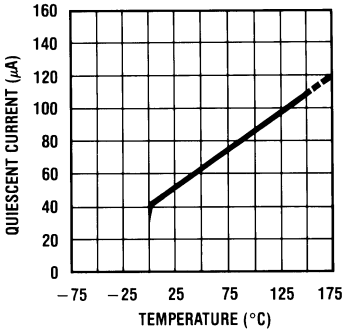
DS005516-28

Minimum Supply Voltage vs. Temperature



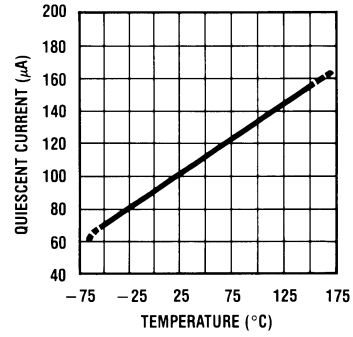
DS005516-29

Quiescent Current vs. Temperature (In Circuit of *Figure 1*.)



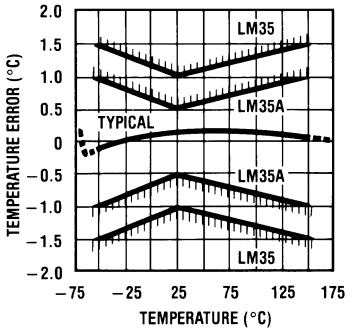
DS005516-30

Quiescent Current vs. Temperature (In Circuit of *Figure 2*.)



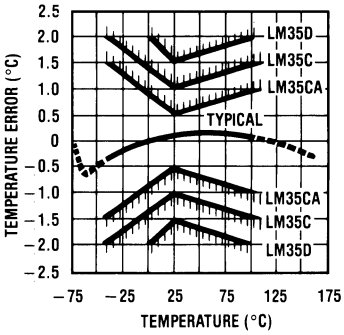
DS005516-31

Accuracy vs. Temperature (Guaranteed)



DS005516-32

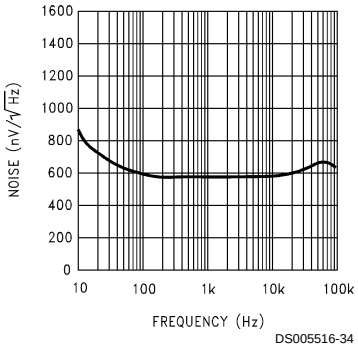
Accuracy vs. Temperature (Guaranteed)



DS005516-33

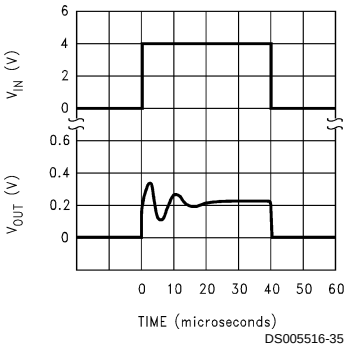
Typical Performance Characteristics (Continued)

Noise Voltage



DS005516-34

Start-Up Response



DS005516-35

Applications

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01˚C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature. This is expecially true for the TO-92 plastic package, where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, be sure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the LM35 die's temperature will not be affected by the air temperature.

The TO-46 metal package can also be soldered to a metal surface or pipe without damage. Of course, in that case the V− terminal of the circuit will be grounded to that metal. Alternatively, the LM35 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM35 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paints or dips are often used to insure that moisture cannot corrode the LM35 or its connections.

These devices are sometimes soldered to a small light-weight heat fin, to decrease the thermal time constant and speed up the response in slowly-moving air. On the other hand, a small thermal mass may be added to the sensor, to give the steadiest reading despite small deviations in the air temperature.

Temperature Rise of LM35 Due To Self-heating (Thermal Resistance, θ_{JA})

	TO-46, no heat sink	TO-46*, small heat fin	TO-92, no heat sink	TO-92**, small heat fin	SO-8 no heat sink	SO-8** small heat fin	TO-220 no heat sink
Still air	400˚C/W	100˚C/W	180˚C/W	140˚C/W	220˚C/W	110˚C/W	90˚C/W
Moving air	100˚C/W	40˚C/W	90˚C/W	70˚C/W	105˚C/W	90˚C/W	26˚C/W
Still oil	100˚C/W	40˚C/W	90˚C/W	70˚C/W			
Stirred oil	50˚C/W	30˚C/W	45˚C/W	40˚C/W			
(Clamped to metal, Infinite heat sink)	(24˚C/W)				(55˚C/W)		

*Wakefield type 201, or 1" disc of 0.020" sheet brass, soldered to case, or similar.
**TO-92 and SO-8 packages glued and leads soldered to 1" square of 1/16" printed circuit board with 2 oz. foil or similar.

Typical Applications

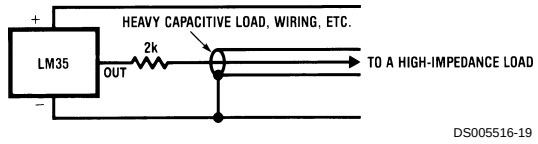


FIGURE 3. LM35 with Decoupling from Capacitive Load

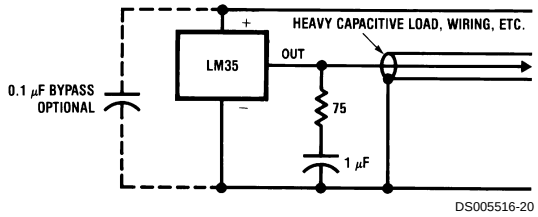


FIGURE 4. LM35 with R-C Damper

CAPACITIVE LOADS

Like most micropower circuits, the LM35 has a limited ability to drive heavy capacitive loads. The LM35 by itself is able to drive 50 pf without special precautions. If heavier loads are anticipated, it is easy to isolate or decouple the load with a resistor; see *Figure 3*. Or you can improve the tolerance of capacitance with a series R-C damper from output to ground; see *Figure 4*.

When the LM35 is applied with a 200Ω load resistor as shown in *Figure 5*, *Figure 6* or *Figure 8* it is relatively immune to wiring capacitance because the capacitance forms a bypass from ground to input, not on the output. However, as with any linear circuit connected to wires in a hostile environment, its performance can be affected adversely by intense electromagnetic sources such as relays, radio transmitters, motors with arcing brushes, SCR transients, etc, as its wiring can act as a receiving antenna and its internal junctions can act as rectifiers. For best results in such cases, a bypass capacitor from V_{IN} to ground and a series R-C damper such as 75Ω in series with 0.2 or 1 μF from output to ground are often useful. These are shown in *Figure 13*, *Figure 14*, and *Figure 16*.

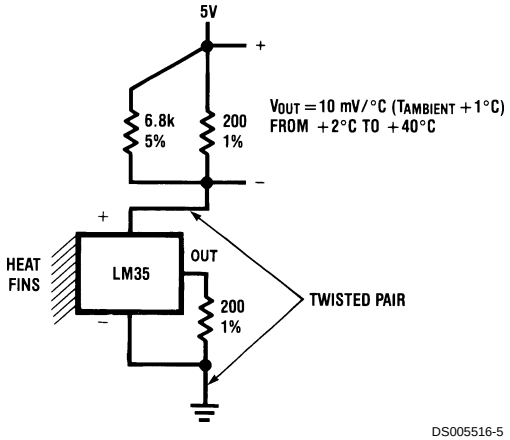


FIGURE 5. Two-Wire Remote Temperature Sensor (Grounded Sensor)

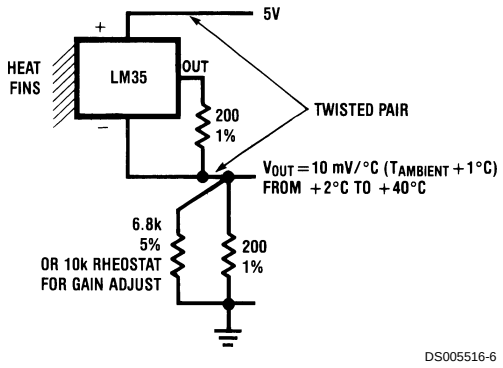


FIGURE 6. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

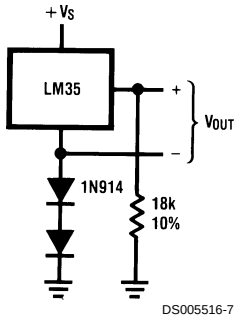


FIGURE 7. Temperature Sensor, Single Supply, −55˚ to +150˚C

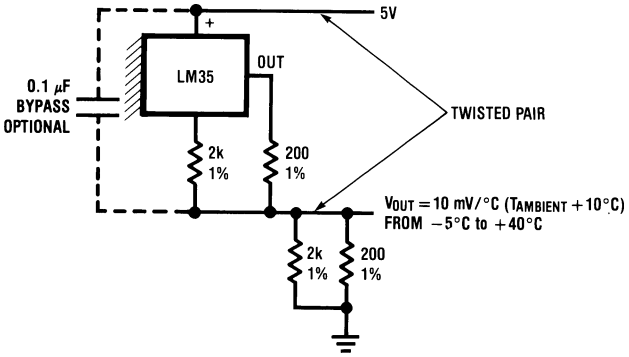


FIGURE 8. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

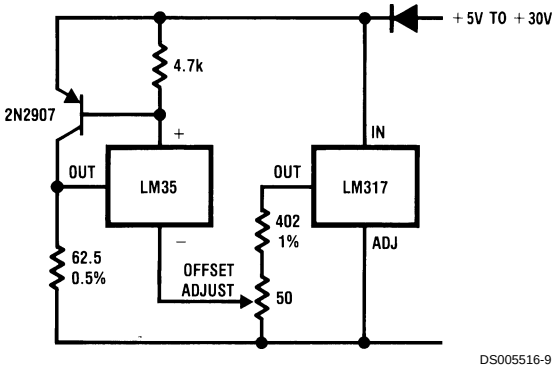


FIGURE 9. 4-To-20 mA Current Source (0˚C to +100˚C)

Typical Applications (Continued)

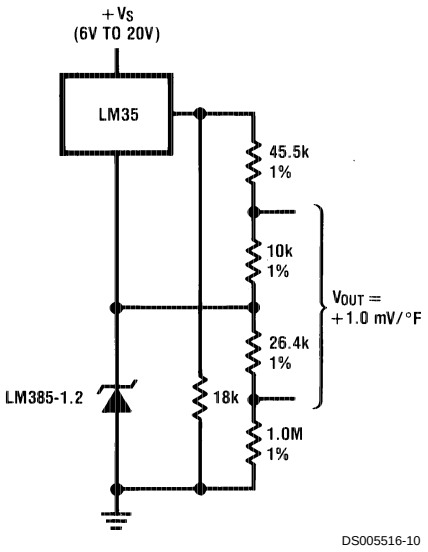


FIGURE 10. Fahrenheit Thermometer

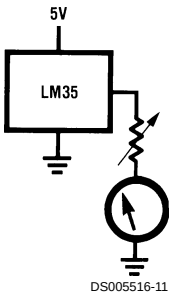


FIGURE 11. Centigrade Thermometer (Analog Meter)

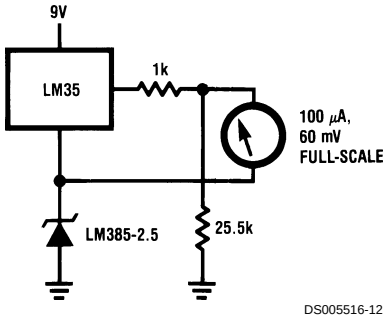


FIGURE 12. Fahrenheit ThermometerExpanded Scale Thermometer
(50˚ to 80˚ Fahrenheit, for Example Shown)

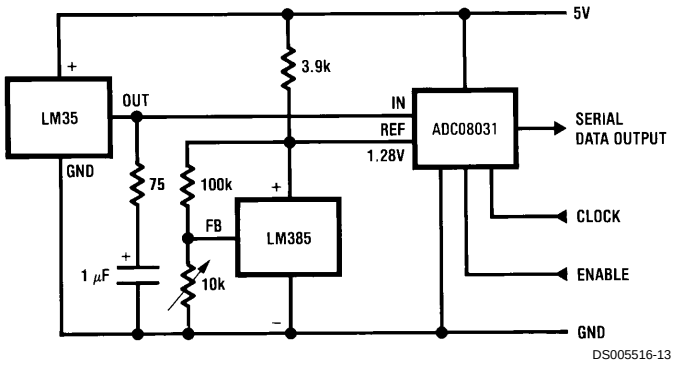


FIGURE 13. Temperature To Digital Converter (Serial Output) (+128˚C Full Scale)

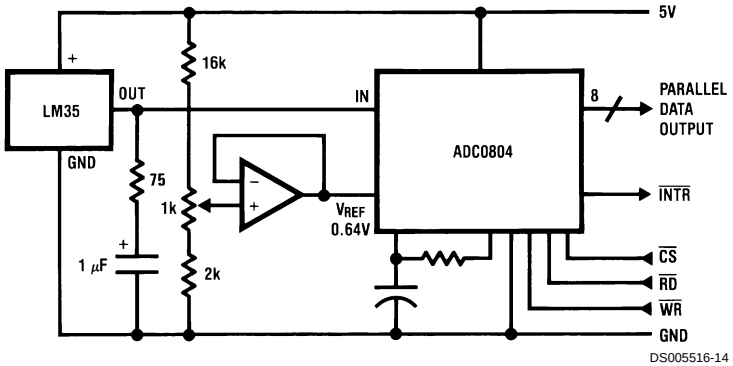
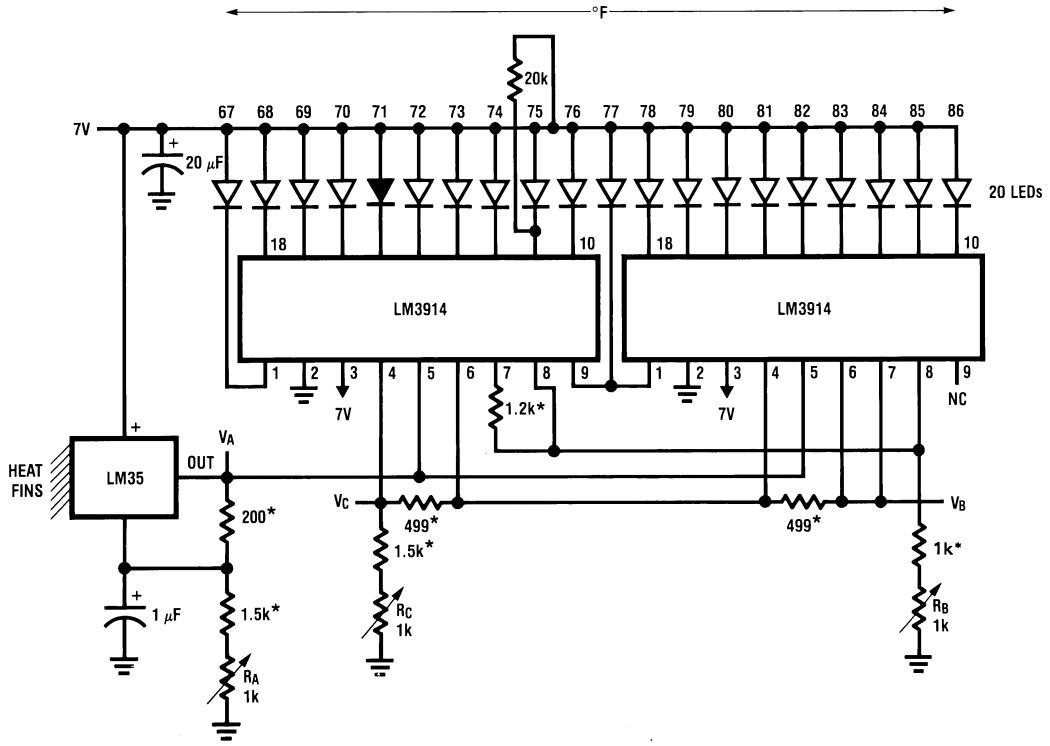


FIGURE 14. Temperature To Digital Converter (Parallel TRI-STATE™ Outputs for Standard Data Bus to μP Interface) (128˚C Full Scale)

Typical Applications (Continued)



*=1% or 2% film resistor
Trim R_B for V_B=3.075V
Trim R_C for V_C=1.955V
Trim R_A for V_A=0.075V + 100mV/°C x $T_{ambient}$
Example, V_A=2.275V at 22°C

FIGURE 15. Bar-Graph Temperature Display (Dot Mode)

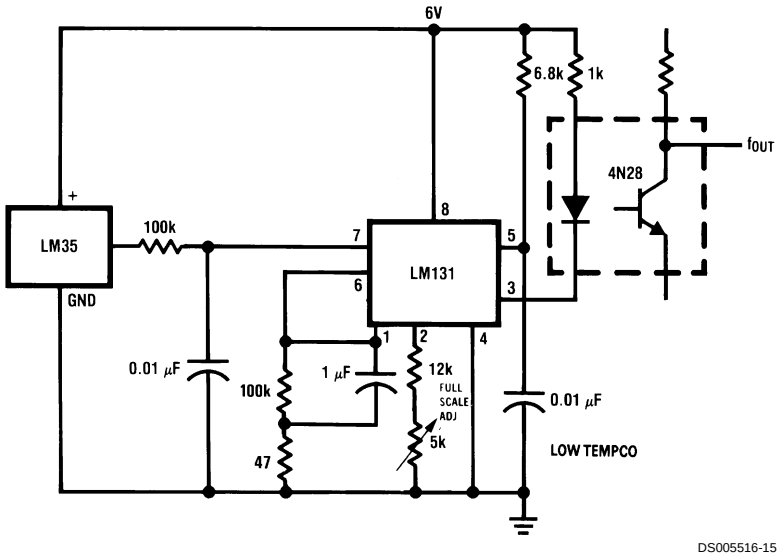
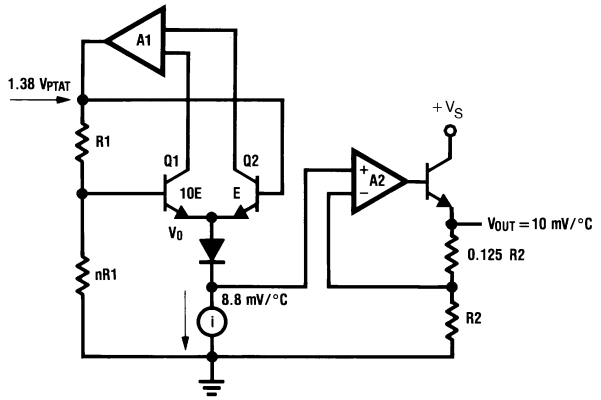


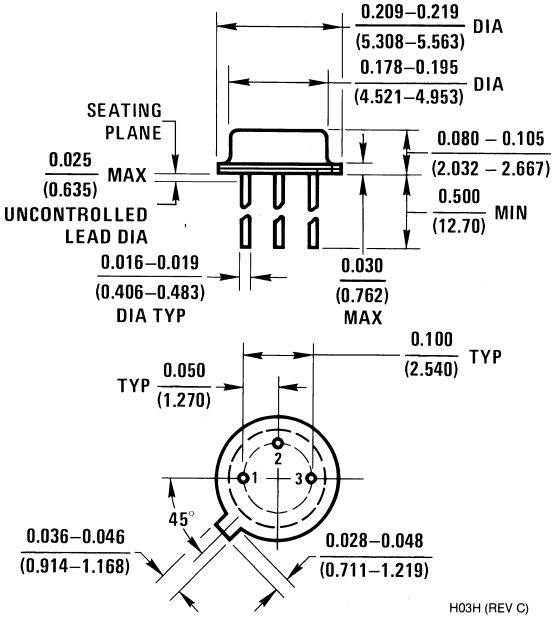
FIGURE 16. LM35 With Voltage-To-Frequency Converter And Isolated Output (2°C to +150°C; 20 Hz to 1500 Hz)

Block Diagram

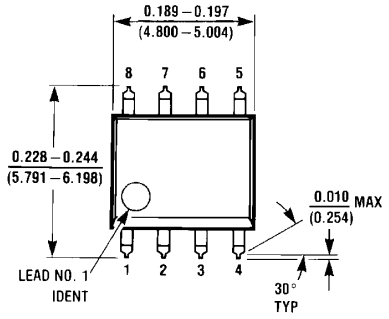


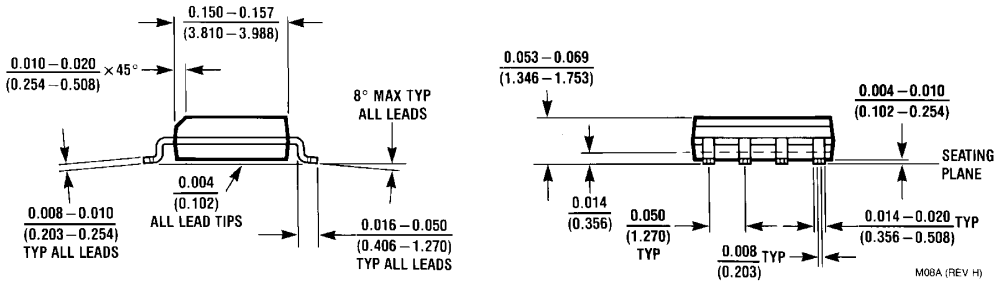
DS005516-23

Physical Dimensions inches (millimeters) unless otherwise noted



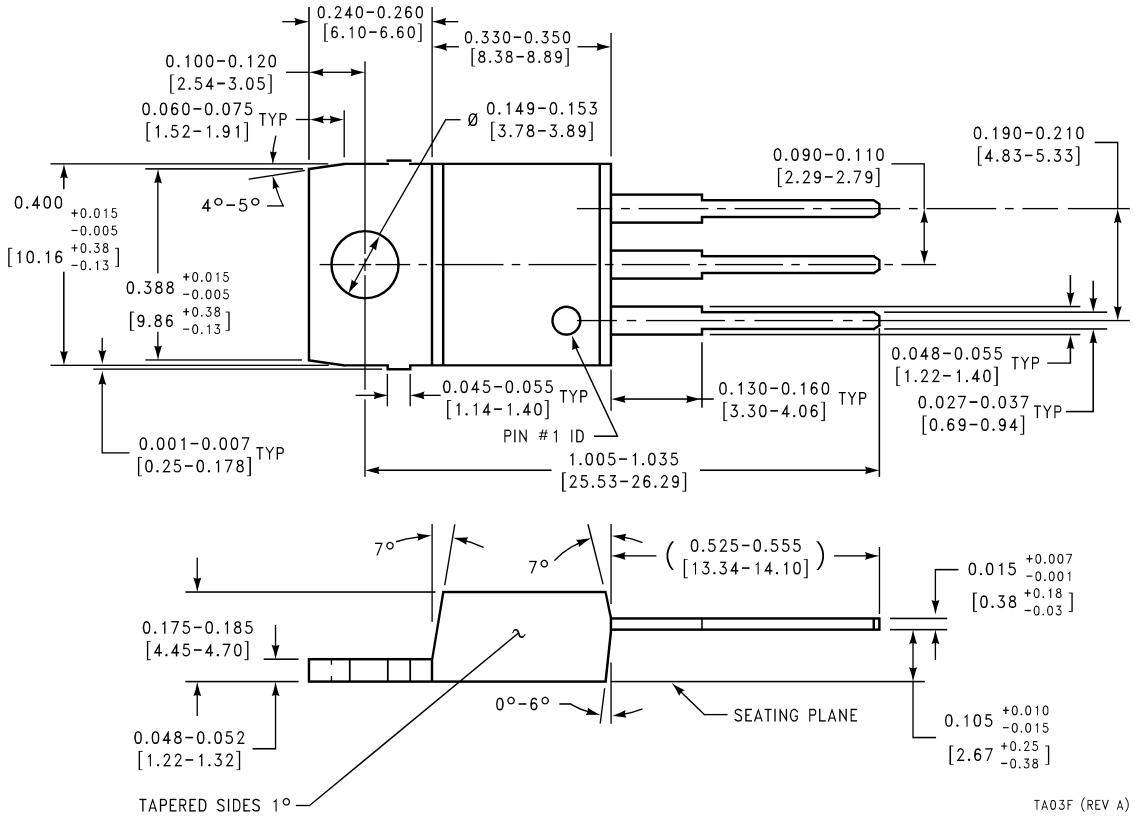
TO-46 Metal Can Package (H)
Order Number LM35H, LM35AH, LM35CH, LM35CAH, or LM35DH
NS Package Number H03H





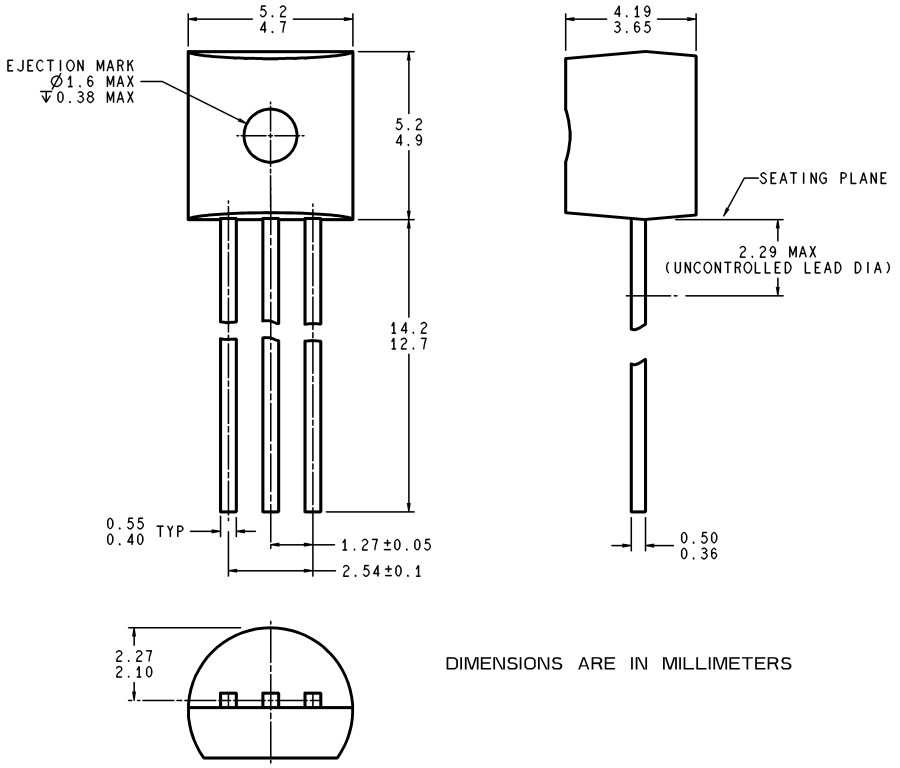
SO-8 Molded Small Outline Package (M)
Order Number LM35DM
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Power Package TO-220 (T)
Order Number LM35DT
NS Package Number TA03F

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



TO-92 Plastic Package (Z)
Order Number LM35CZ, LM35CAZ or LM35DZ
NS Package Number Z03A

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4.2. Documento Oficial Placa Arduino Uno

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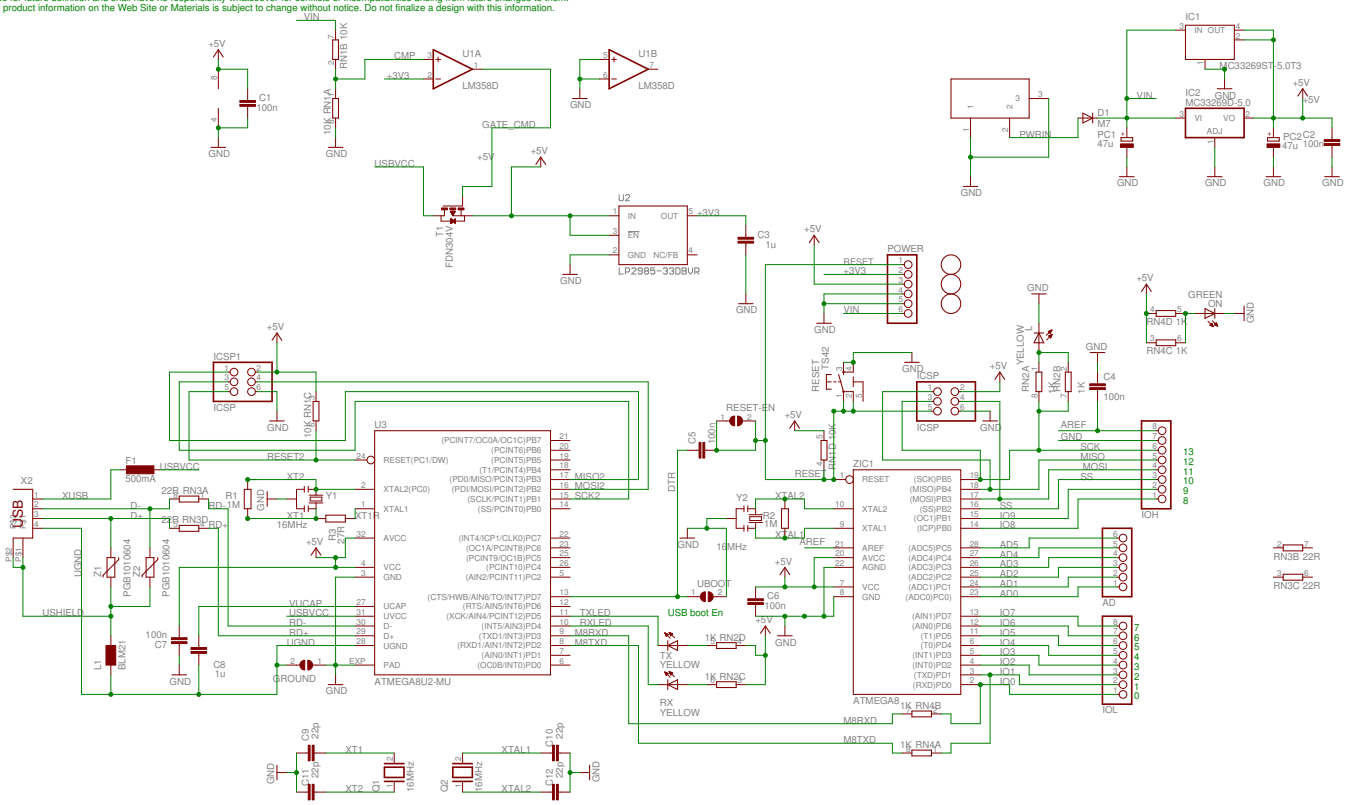


4.3. Documento Oficial Cable USB Tipo AB

May 23, 2007

To: USB Members and Vendors
RE: Deprecation of the Mini-A and Mini-AB Connectors

Dear USB Developer,

With the recent introduction of the Micro-USB connectors, the USB-IF is taking the strong step to deprecate the Mini-A and Mini-AB connectors in order to minimize the number of cable combinations required to support the various product interconnections and minimize marketplace confusion. Based upon this, the USB-IF will no longer certify products that use the Mini-A and Mini-AB connectors nor products that use them. This change is effective immediately. Vendors of USB On-The-Go (OTG) products are directed to **adopt the Micro-AB receptacle on all new OTG designs** in lieu of the Mini-AB previously approved for this application. In addition, all Mini-A and Mini-AB connectors that are currently on the Integrators List will be removed.

Specifications
The USB Mini- and Micro-series connectors are defined in the following specifications:

§ **Micro-USB Cables and Connectors Specification, Version 1.01 (**http://www.usb.org/developers/docs/) – This newly released document defines the Micro-B receptacle (for USB peripherals), the Micro-AB receptacle (for OTG products) and the associated cables and plugs. The new Micro-series connectors offer a smaller footprint, improved insertion/extraction forces, passive latching and improved robustness.

§ **On-The-Go Supplement to the USB 2.0 Specification, Version 1.3** – Previous versions of the OTG specification contained protocol and mechanical definitions, in this new version the mechanical section is removed. The Mini-A and Mini-AB cables and connectors previously defined in the OTG Supplement no longer have a place in any USB current specification.

§ **Mini-B ECN to the USB 2.0 Specification** – This document remains unchanged. It defines the Mini-B receptacle as well as associated plugs and cables.

Compliance Changes

§ **Receptacles on non-OTG products** – Portable non-OTG products may use either the Mini-B receptacle or the new Micro-B receptacle. The USB Standard-B receptacle is still recommended for products with adequate room.

§ **Receptacles on OTG products** – All products seeking OTG certification will be required to use one, and only one, Micro-AB receptacle and no other USB receptacles. (The Micro-AB receptacle is not approved on non-OTG products.) Products using the Mini-A and Mini-AB receptacles will no longer be eligible for USB-IF certification and are strongly discouraged.

§ **Cables and adapters** –The USB-IF is taking the strong step of deprecating the Mini-A and Mini-AB connectors in order to minimize the number of cable combinations required to support the various product interconnections. Cables with the following connector combinations will be eligible for USB certification:

Cable	Application
Std-A plug to Std-B plug	Primary cable for connecting Std-B peripherals to PCs and other hosts
Std-A plug to Mini-B plug	Primary cable for connecting Mini-B peripherals to PCs and other hosts
Std-A plug to Micro-B plug	New – Primary cable for connecting Micro-B or Micro-AB peripherals to PCs and other hosts
Micro-A plug to Std-A receptacle (Adapter)	New – Provides OTG products with the same receptacle (Std-A) that is available on PCs. Any peripheral that can connect to a PC can connect to an OTG product by using this adapter
Micro-A plug to Micro-B plug	New – Allows direct interconnection between OTG products
Hard-wired captive cable with Micro-A plug	New – Supported on products, such as roll-up keyboards, that are targeted exclusively for use with OTG hosts

No new certification of any of the following will be allowed:

Products with Mini-AB or Mini-A receptacles
Products with hardwired captive cables using Mini-A plugs
Cables with Mini-A plugs

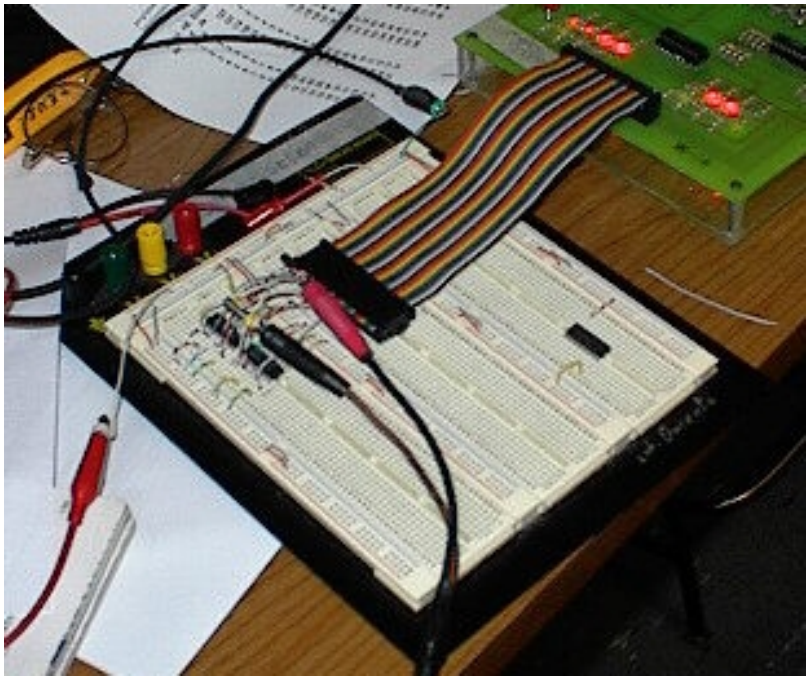
Temporary Waivers
Whenever the USB-IF makes a change to certification requirements, it is our policy to continue to allow certification under the prior requirements for a short period of time. While OTG products using the Mini-AB will be eligible for waiver certification for a few months, OTG product vendors are strongly encouraged to rapidly adopt the new Micro-AB to ensure that their products offer maximum compatibility with other OTG products.

Sincerely,
USB-IF Administration

USB Implementers Forum, Inc. ▪ 3855 SW 153rd Drive ▪ Beaverton, Oregon 97006
Tel: 503.619.0426 ▪ Fax: 503.644.6708 ▪ Email: admin@usb.org ▪ www.usb.org

4.4. Documento Oficial Protoboard

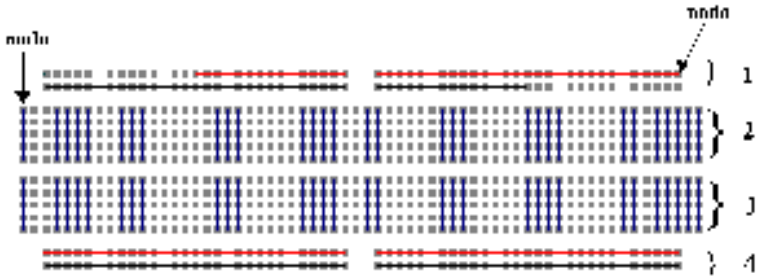
El Protoboard



El Protoboard, o tableta experimental, es una herramienta que nos permite interconecar elementos electronicos, ya sean resistencias, capacidades, semiconductores, etc, sin la necesidad de soldar las componentes.

El protoboard esta lleno de orificios metalizados -con contactos de presion- en los cuales se insertan las componentes del circuito a ensamblar. La siguiente figura muestra la forma basica de un protoboard, estando los protoboards mas grandes compuestas de varias de estos.

La tableta experimental esta dividida en cuatro secciones, y cada una de estas se encuentran separadas por un material aislante. Los puntos de cada seccion estan conectados entre si tal como lo muestra la figura:



Las secciones uno y cuatro estan formadas por dos lineas o nodos. Estas son normalmente utilizados para conectar la alimentacion del circuito, y asi energizarlo. Por otro lado en las secciones dos y tres se encuentran conectados cinco orificios verticalmente, formando pequeños nodos independientes unos de otros. Recuerde que la figura muestra como estan conectados internamente los orificios, por lo que no es necesario rehacer estas conexiones.

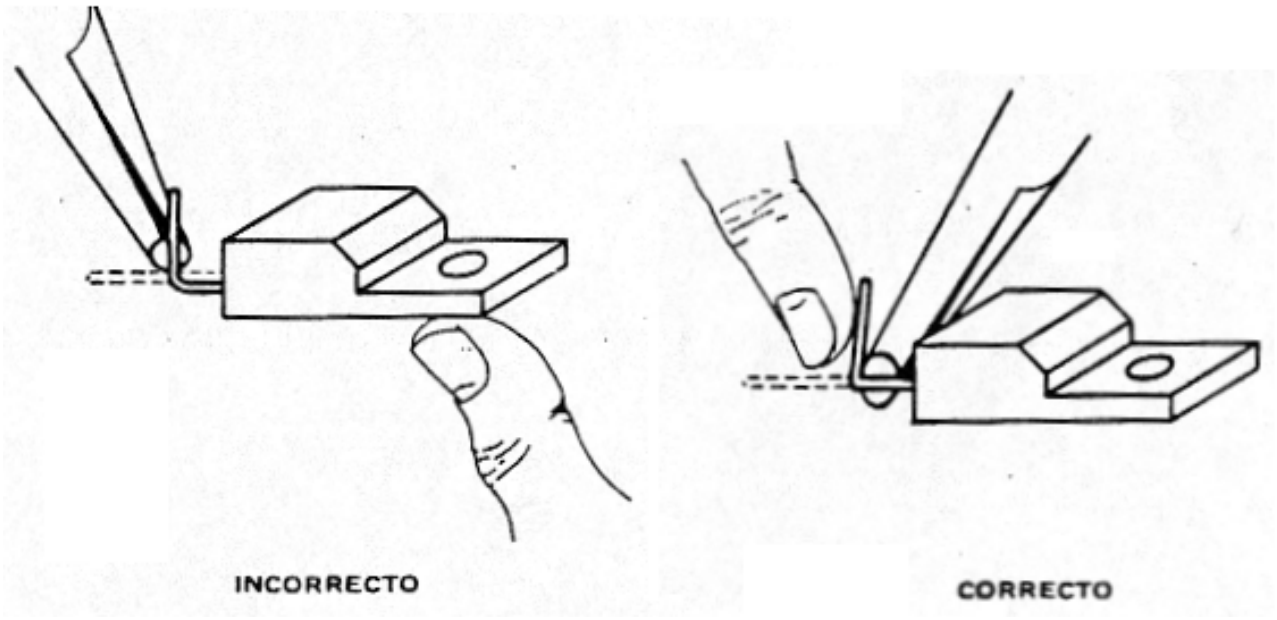
Forma de Utilizar un Protoboard, y consejos la ensamblar

1. - Un buen consejo es hacer conexion de las mitades de las secciones uno y cuatro, tal como lo nuestra la figura

asi, se mantendra una configuracion clara y entendible.

2. - La conexion entre nodos se hace mediante *alambres*, los cuales deben de ser **lo mas corto posible**, a fin de evitar problemas de ruido en el circuito. En lo posible deben de estar aislados, para evitar cortocircuitos por contactos con otros cables

3. - Al montar las componentes fijese muy bien en las polaridades, por ejemplo de condensadores, y valores de pines de los integrados, asi como rangos de operacion. Trate de ser ordenado en el armado, doblando correctamente pines y conectores, tal como lo muestra la figura.



4. - Si el circuito no funciona correctamente revise las alimentaciones y que los cables de interconexion de nodos no esten sueltos o haciendo mal contacto. Existe alta probabilidad de que esto ocurra. Si Ud considera que el circuito esta bien ensamblado, y aun asi hay problemas, mueva el circuito dentro del proto -de lugar- o utilize otro protoboard. Recuerde que todas las herramientas tienen una vida util

5. - El protoborad tiene bastantes problemas de ruido por lo que **no se recomienda para alta frecuencia**

6. - Finalmente recuerde que esta herramienta es para ensamblado temporal. Si Ud desea mantaner el circuito llevelo a placa -PCB-, replicandolo, tratando en lo posible de usar otras componentes, a fin de poder identificar posibles problemas en la placa

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